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Tonic Immobility Mediates the Influence of Peritraumatic Fear and Perceived Inescapability on Posttraumatic Stress Symptom Severity Among Sexual Assault Survivors

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This study evaluated whether tonic immobility mediates the relations between perceived inescapability, peritraumatic fear, and posttraumatic stress disorder (PTSD) symptom severity among sexual assault survivors. Female undergraduates (N = 176) completed questionnaires assessing assault history, perceived inescapability, peritraumatic fear, tonic immobility, and PTSD symptoms. Results indicated that tonic immobility fully mediated relations between perceived inescapability and overall PTSD symptom severity, as well as reexperiencing and avoidance/numbing symptom clusters. Tonic immobility also fully mediated the relation between fear and reexperiencing symptoms, and partially mediated relations between fear and overall PTSD symptom severity, and avoidance/numbing symptoms. Results suggest that tonic immobility could be one path through which trauma survivors develop PTSD symptoms. Further study of tonic immobility may inform our ability to treat trauma victims.

In response to life-threatening circumstances that are both inescapable and elicit intense fear (e.g., capture by a predator; Gallup, Nash, Donegan, & McClure, 1971), animals often exhibit a set of unconditioned responses that include gross motor inhibition, motor tremors, analgesia, suppressed vocal behavior, fixed and unfocused stare, and periods of eye closures. These behaviors are known collectively as tonic immobility (Gallup, 1977; Marx, Forsyth, Heidt, Fusé, & Gallup, 2008). Tonic immobility is thought to be the ultimate response in a series of defense reflexes (i.e., freezing, flight, fight, tonic immobility) observed among many animal species that are elicited by circumstances involving imminent danger where escape is impossible (Fanselow, 1994; Gallup & Rager, 1996; Marx et al., 2008; Ratner, 1967). Given that predators are less likely to attack or kill immobile prey, tonic immobility is an evolutionarily adaptive strategy that increases the animal's chances of escape (Gallup & Rager, 1996; Marks, 1987; Thompson et al., 1981).

Although sometimes confused, tonic immobility is different from the freezing behavior that occurs early in the encounter stage of the defensive reflex (Marks, 1987; Ratner, 1967). Freezing is an initial response during which the animal stops moving to avoid detection and shifts resources to locate the predator. Freezing is associated with increased responsivity to stimuli, alert posture, and volitional action tendencies (Marks, 1987), whereas tonic immobility involves motionless posture and unresponsiveness to painful stimulation (Gallup & Rager, 1996; Marx et al., 2008).

Tonic immobility is often associated with predatory attack, but can be simulated in the laboratory with animals. In both naturalistic settings and laboratory inductions, tonic immobility is elicited by extended physical restraint and intense fear (Gallup et al., 1971). Although fear is regarded as an essential component for the induction of tonic immobility (Gallup, 1977), it is not sufficient for tonic immobility elicitation. Among animals, tonic immobility can only be elicited under conditions in which restraint and fear occur. However, in the context of physical restraint, the magnitude of fear is perhaps the most important antecedent variable affecting the phenomenology of tonic immobility (Marx et al., 2008).

Researchers previously hypothesized that anecdotal reports of paralysis and inability to call out during the assault experienced by some sexual assault survivors might be an expression of tonic

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immobility in humans (cf. Suarez & Gallup, 1979). Galliano, Noble, Travis, and Puechl (1993) conducted preliminary research on immobility reactions displayed by rape victims. They classified the behavior of participants during their assaults as immobile, mobile, or intermediate, based on participants' retrospective self-reports. Almost 40% of participants were classified as exhibiting immobility during their assault, and these participants were more likely than mobile or intermediate participants to experience other features known to characterize tonic immobility in animals, including motor inhibition, tremors, eye closure, and reduced core body temperature (i.e., a subjective feeling of coldness). It has been further hypothesized that tonic immobility is a likely response to a sexual assault given that the conditions that induce tonic immobility in animals, namely fear and physical restraint (or perceived inescapability), are analogous to the conditions usually present during a sexual assault (Suarez & Gallup, 1979). Recent findings have corroborated the notion that a substantial number of survivors (41%–52%) experience tonic immobility during their sexual assaults (e.g., Fusé, Forsyth, Marx, Gallup, & Weaver, 2007; Heidt, Marx, & Forsyth, 2005). Further, the experience of tonic immobility has been associated with greater psychological distress and functional impairment. For instance, Heidt et al. (2005) showed that tonic immobility during a sexual assault is associated with greater depression, anxiety, and PTSD symptoms among survivors. Fusé et al. (2007) and Heidt et al. (2005) showed that tonic immobility is strongly related to peritraumatic dissociation.

Peritraumatic response has been identified as a risk factor for the development of PTSD following trauma (e.g., Brewin, Andrews, & Valentine, 2000; Ozer, Best, Lipsey, & Weiss, 2003). For example, Ozer and colleagues (2003) found that intense, negatively valenced peritraumatic responses (e.g., fear) were strongly related to PTSD status. Although empirical literature linking peritraumatic perceptions of inescapability to PTSD is unavailable, there is reason to believe that this link exists. Specifically, Foa, Zinbarg, and Rothbaum (1992) suggested that disturbances observed in animals subjected to unpredictable and uncontrollable (i.e., inescapable) aversive events resemble PTSD symptoms, and may constitute an animal model of the disorder. These authors provided evidence that animals subjected to inescapable aversive stimuli (more so than those subjected to escapable aversive stimuli) subsequently exhibited responses (e.g., fear, heightened arousal, analgesia, passive avoidance) that resemble PTSD symptoms. Thus, it seems reasonable to conclude that humans subjected to inescapable aversive situations are at risk for developing PTSD. Importantly, peritraumatic conditions (fear and perceived inescapability), which are thought to serve as risk factors for PTSD, are the same conditions known to elicit tonic immobility. The fact that tonic immobility temporally occurs after peritraumatic fear and perceived inescapability and before the onset of PTSD symptoms suggests that tonic immobility may serve as the generative mechanism through which these initial peritraumatic responses promote PTSD onset. This possibility is bolstered by previous work showing that tonic immobility is associated with greater PTSD symptom severity (e.g., Heidt et al., 2005).

In this study, we examined the relations among peritraumatic fear, perceived inescapability, tonic immobility, and PTSD symptomatology. We hypothesized that tonic immobility would mediate the relations between the combined effects of peritraumatic fear and perceived inescapability and PTSD symptom severity. Because previous research has shown that other peritraumatic experiences (e.g., dissociation) that are associated with tonic immobility significantly predict each of the PTSD symptom clusters (Birmes et al., 2003; O'Toole, Marshall, Schureck, & Dobson, 1999), we hypothesized that tonic immobility would mediate the relations between peritraumatic fear, perceived inescapability, and overall PTSD symptom severity, as well as all of the separate PTSD symptom clusters (reexperiencing, avoidance/numbing, and hyperarousal).

METHOD

Participants

Potential participants were recruited through posted notices and announcements for a larger investigation of risk factors for future sexual victimization. Participants were 189 female college undergraduates at an urban university in the United States, who endorsed at least one item on the Sexual Experiences Survey (SES; Koss & Gidycz, 1985). Thirteen women in the sample did not complete the Tonic Immobility Scale–Adult Form (TIS-A; Forsyth, Marx, Fusé, Heidt, & Gallup, 2000). Because the results of our analyses did not differ significantly when these participants were removed, they were excluded from the final report. The final sample ($N = 176$) ranged in age from 19–39 years ($M = 22.9$, $SD = 3.2$) and was 68% Caucasian, 20% African American, 3% Asian, 3% Latina, and 4% Mixed/Other; 2% did not report their ethnicity. All participants reported at least one sexual assault during adolescence or adulthood, defined as sexual aggression or victimization occurring at or after age 14.

Measures

History of sexual assault was assessed using the SES (Koss & Gidycz, 1985). The SES is a 10-item (yes/no) self-report questionnaire that assesses various possible victimization experiences and encourages accurate responding by avoiding the use of words like "rape." Questions ask about four levels of unwanted sexual experiences: sexual contact (i.e., unwanted sexual contact that does not involve attempted penetration), sexual coercion (i.e., unwanted sexual intercourse subsequent to the use of verbal pressure or the misuse of authority), attempted rape (i.e., attempted unwanted sexual intercourse occurring subsequent to the use of force, threats of force, or alcohol/drug administration), and completed rape (i.e., unwanted sexual intercourse subsequent to the use of force, threats of force, or alcohol/drug administration) occurring

at or after age 14. Possible scores range from 0–10. A sample item is "From age 14 on, have you ever had sexual intercourse when you didn't want to because someone gave you alcohol or drugs?"

Koss and Gidycz (1985) demonstrated moderately strong internal consistency (Cronbach's alpha) of .74 in a sample of women and strong one-week test–retest reliability of .93. In their study, the Pearson correlation between self-reported levels of victimization on the SES and reports to interviewers was .73 (Koss & Gidycz, 1985).

Posttraumatic stress disorder symptomatology was assessed using the Posttraumatic Stress Diagnostic Scale (PDS; Foa, Cashman, Jaycox, & Perry, 1997). The PDS is a 49-item self-report questionnaire that assesses the presence and severity of PTSD, according to the criteria set in the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (*DSM-IV*; American Psychiatric Association, 1994). Seventeen items assess PTSD symptomatology within the last month. These items are scored on a Likert scale ranging from 0 = *not at all/only one time* to 3 = *five or more times a week/almost always*. Scores range from 0 to 51, with higher scores signifying greater symptom severity. In addition to overall severity, the PDS provides severity scores for the reexperiencing, avoidance/numbing, and hyperarousal symptom clusters. A sample item is "In the past month, how often have you been having trouble falling or staying asleep?"

Strong internal consistency has been demonstrated for the PDS, with a coefficient alpha of .92 for the total PDS severity score and coefficient alphas of .78 for Reexperiencing, .84 for Avoidance/Numbing, and .84 for Hyperarousal subscales (Foa et al., 1997). Strong 2-week test–retest reliability has been shown for both PTSD diagnoses (.74) and symptom severity (effect sizes for change in symptom severity over a 2-week interval range from .12 to .17, demonstrating clinically insignificant changes; Foa et al., 1997). The validity of PTSD diagnoses obtained via the PDS was ascertained by comparison with the Structured Clinical Interview for DSM-III-R–Posttraumatic Stress Disorder (SCID-PTSD) module (Spitzer, Williams, Gibbon, & First, 1990) and was shown to be strong ($\kappa = .65$, with 82% agreement between measures; Foa et al., 1997).

Tonic immobility and its two antecedent conditions, peritraumatic fear and perceived inescapability, were assessed using the Tonic Immobility Scale–Adult Form (TIS-A; Forsyth, Marx, Fusé, Heidt, & Gallup, 2000). The TIS-A is a two-part, 30-item questionnaire developed to assess the degree to which an individual experiences various aspects of the tonic immobility response during an episode of adult sexual assault (ASA). Respondents are asked to answer questions in reference to their most recent ASA episode.

Part 1 contains 12 items that assess dimensional aspects of the tonic immobility response and its antecedents. These items are rated on a 7-point Likert-type scale (ranging from 0 to 6). Part 2 contains 17 items that assess specific victim and perpetrator behaviors known to co-vary with tonic immobility (e.g., feeling cold), as well as hypothesized emotional reactions to the event (e.g., hostility toward attacker). Respondents complete Part 2 only if they lost the ability to resist the attacker voluntarily or move (e.g., felt frozen or paralyzed) during an instance of ASA. The first seven items of Part 2, rated using a 7-point Likert-type format, assess phenomenological aspects of tonic immobility. The remaining Part 2 items assess specific aspects of the assault and are answered in a yes/no format. Part 2 of the TIS-A was not used in the current investigation.

An exploratory factor analysis of the items in Part 1 of the TIS-A within a sample of female undergraduate sexual assault survivors (Fusé, Forsyth, Marx, Karekla, & Gallup, 2002) yielded a two-factor solution, accounting for 67.3% of the variance. These two independent factors were a tonic immobility factor (seven items; 43.8% of the variance) and a peritraumatic fear factor (three items; 23.5% of the variance). A sample tonic immobility item is "Rate the degree to which you froze or felt paralyzed during your most recent adult experience," and scores range from 0 to 42. A sample fear item is "Rate the extent to which you felt feelings of fear/panic during the event," and scores range from 0 to 18. Loadings of individual items on the tonic immobility factor ranged from .48 to .92, whereas loadings of individual items on the fear factor ranged from .83 to .91. Both factors showed strong internal consistency (αs = .94 and .90 for the tonic immobility and fear factors, respectively). These results were replicated with a confirmatory factor analysis (Fusé et al., 2007).

The psychometric evaluations conducted to date suggest that the TIS is a content valid and psychometrically sound 2-factor instrument to assess tonic immobility and peritraumatic fear during sexual assault (e.g., Fusé et al, 2007). In this study, the tonic immobility factor demonstrated moderately strong internal consistency ($\alpha = .80$), although the peritraumatic fear factor did not ($\alpha = .44$). Higher scores on tonic immobility and peritraumatic fear subscales indicate more severe tonic immobility symptomatology and peritraumatic fear during the assault and these separate scales were used to assess tonic immobility and peritraumatic fear, respectively.

For the purpose of this investigation, one additional item was added to Part 1 of the TIS-A to assess perceived inescapability during sexual assault. The item asks participants to "Rate the extent to which you felt that you were unable to escape during the assault" and is scored on a Likert-type scale ranging from 0 = *could escape easily* to 6 = *could not escape at all*. In all, 11 items across three separate scales within the TIS-A were used to measure tonic immobility, peritraumatic fear, and perceived inescapability. Seven items assessed tonic immobility, three different items measured fear, and one additional item measured participants' perceived inescapability during the assault.

Procedure

Subsequent to contacting us for the purpose of volunteering, each participant was given an individual appointment in the lab. At this lab session, participants provided informed consent and completed

several questionnaires. Following completion, participants were debriefed, invited to ask questions, and provided with counseling referrals. Procedures were approved by the university institutional review board.

RESULTS

Descriptive Data

Among our sample, tonic immobility scores ranged from 0 to 36 ($M = 15.30$, $SD = 8.12$), fear scores ranged from 0 to 18 ($M = 7.27$, $SD = 4.16$), and perceived inescapability scores ranged from 0 to 6 ($M = 2.63$, $SD = 2.27$). Total PDS scores ranged from 0 to 43 ($M = 10.19$, $SD = 10.13$), PDS reexperiencing scores ranged from 0 to 15 ($M = 3.06$, $SD = 3.06$), PDS avoidance scores ranged from 0 to 19 ($M = 3.71$, $SD = 4.31$), and PDS hyperarousal scores ranged from 0 to 15 ($M = 3.42$, $SD = 3.97$). Bivariate correlations were conducted to examine the associations among these seven variables; all variables were significantly correlated (all $ps < .001$; see Table 1). By all indicators, none of the predictors in this study showed evidence of multicollinearity. Specifically, no bivariate correlations were above .8 (Lewis-Beck, 1980), all variance inflation factors were below 100, and all tolerance statistics were greater than .01 (Afifi, Clark, & May, 2004).

In reporting their most severe sexual assault experiences, 48% of the sample reported rape ($n = 86$), 23% reported attempted rape ($n = 42$), 24% reported sexual coercion ($n = 43$), and 2% reported unwanted sexual contact ($n = 5$). Using Sheeran and Zimmerman (2002)'s cutoff score of 27 on the PDS, 18 participants (approximately 10% of the sample) qualified for a diagnosis of PTSD. For these women, total PDS scores ranged from 27 to 43 ($M = 31.67$; $SD = 4.99$), reexperiencing scores ranged from 3 to 15 ($M = 8.50$; $SD = 3.17$), avoidance scores ranged from 7 to 19 ($M = 12.61$; $SD = 3.62$), and hyperarousal scores ranged from 7 to 15 ($M = 10.56$; $SD = 2.17$). Tonic immobility scores ranged from 4 to 36 ($M = 21.06$; $SD = 7.01$), fear scores ranged from 0 to 18 ($M = 10.33$; $SD = 4.90$), and perceived inescapability scores ranged from 0 to 6 ($M = 3.89$; $SD = 2.14$). Among these participants, 77.8% endorsed rape ($n = 14$), 16.7% endorsed attempted rape ($n = 3$), and 5.6% endorsed unwanted sexual contact ($n = 1$).

For women who reported less severe assault experiences (either unwanted sexual contact or sexual coercion; $n = 48$), fear scores ranged from 0 to 15 ($M = 5.37$; $SD = 4.02$), perceived inescapability scores ranged from 0 to 6 ($M = 1.31$; $SD = 1.70$), tonic immobility scores ranged from 0 to 29 ($M = 11.81$; $SD = 7.19$), and PDS scores ranged from 0 to 28 ($M = 6.23$; $SD = 7.23$). In contrast, for women who reported more severe experiences (attempted rape or rape; $n = 128$), fear scores ranged from 0 to 18 ($M = 7.97$; $SD = 4.00$), perceived inescapability scores ranged from 0 to 6 ($M = 3.13$; $SD = 2.27$), tonic immobility scores ranged from 1 to 36 ($M = 16.60$; $SD = 8.08$), and PDS scores ranged from 0 to 43 ($M = 11.67$; $SD = 10.67$). The differences between the two groups on each of the four variables were significant (all $ts > 3.80$; all $ps < .001$). Due to power limitations, these groups could not be separately subjected to multiple regression analyses. Therefore, for all subsequent analyses, these groups were collapsed.

Mediation Analyses

Baron and Kenny's (Baron & Kenny, 1986; Kenny, Kashy, & Bolger, 1998) criteria for mediation were followed. For mediation to occur, (a) the independent variables (IVs; perceived inescapability and fear) must significantly predict the mediator (tonic immobility), (b) the IVs must significantly predict the dependent variables (DVs; total PDS score and reexperiencing, avoidance, and hyperarousal scores), (c) the mediator must significantly predict the DVs when controlling for the IVs, and (d) the impact of the IVs on the DVs must be significantly less after controlling for the mediator.

The first condition for the model was met: fear and perceived inescapability significantly predicted 44.7% of the variance in tonic immobility scores, adjusted $R^2 = .45$; $F(2, 175) = 71.81$,

Table 1. Correlational Relationships Between Perceived Inescapability, Fear, Tonic Immobility, and the Four Outcome Measures ($N = 176$)

Variable	1	2	3	4	5	6	7
1. Fear	–	.32*	.40*	.22*	.29*	.27*	.30*
2. PI		–	.64*	.26*	.27*	.27*	.30*
3. TI			–	.31*	.34*	.25*	.34*
4. Reexperiencing				–	.69*	.69*	.87*
5. Avoidance					–	.70*	.91*
6. Hyperarousal						–	.90*
7. PDS Total							–

Note. PI = Perceived inescapability; TI = tonic immobility; Reexperiencing = reexperiencing symptoms as assessed by the Posttraumatic Diagnostic Scale; Avoidance = avoidance symptoms as assessed by the Posttraumatic Diagnostic Scale; Hyperarousal = hyperarousal symptoms as assessed by the Posttraumatic Diagnostic Scale; PDS Total = total PTSD score as assessed by the Posttraumatic Diagnostic Scale.

* $p < .01$.

Table 2. Hierarchical Multiple Regressions of Posttraumatic Stress Disorder (PTSD) Symptom Severity on Fear and Perceived Inescapability (Step 2) and on Fear, Perceived Inescapability and Tonic Immobility (Step 3): Standardized Results (βs) ($N = 176$)

	PDS Total		Reexperiencing		Avoidance		Hyperarousal
Independent variables	Step 2	Step 3	Step 2	Step 3	Step 2	Step 3	Step 2
Fear	.22**	.18*	.15*	.10	.23**	.18*	.21**
Perceived inescapability	.23**	.12	.22**	.09	.20*	.07	.21**
Tonic immobility		.19*		.21*		.22*	
Adjusted R^2	.12***	.14***	.08***	.10***	.11***	.13***	.10***

Note. PI = Perceived inescapability; TI = tonic immobility; Reexperiencing = reexperiencing symptoms as assessed by the Posttraumatic Diagnostic Scale; Avoidance = avoidance symptoms as assessed by the Posttraumatic Diagnostic Scale; Hyperarousal = hyperarousal symptoms as assessed by the Posttraumatic Diagnostic Scale; PDS Total = total PTSD score as assessed by the Posttraumatic Diagnostic Scale.
* $p < .05$. ** $p < .01$. *** $p < .001$.

$p < .001$, and both fear ($\beta = .21$, $p < .001$) and perceived inescapability ($\beta = .57$, $p < .001$) predicted tonic immobility scores. Similarly, the second condition was met (see Table 2); fear and perceived inescapability predicted PDS reexperiencing, avoidance, hyperarousal, and overall scores. With one exception, the third condition was met. Specifically, tonic immobility scores predicted all DVs except for hyperarousal scores ($\beta = .07$, *ns*). As a result, tonic immobility was not evaluated as a mediator of hyperarousal symptoms.

Finally, the fourth condition was examined. With the mediator present, the predictive value of fear and perceived inescapability was reduced for PDS total score, PDS reexperiencing score and PDS avoidance score. Specifically, fear no longer significantly predicted reexperiencing scores, indicating complete mediation by tonic immobility. However, fear remained significant in predicting PDS total scores and avoidance scores, indicating partial mediation by tonic immobility. In contrast, perceived inescapability was no longer a significant predictor of PDS total scores, PDS reexperiencing scores or PDS avoidance scores, indicating tonic immobility completely mediated all three variables (see Table 2).

Because the Sobel test for mediation was designed to test mediation models that include only one predictor, we could not use this test with our full model. However, this test was used to confirm the mediation results because the Sobel test has more power than the Baron and Kenny method (Preacher & Hayes, 2004). Regressions were rerun with each independent variable separately and these results were applied to the Sobel test. Because these regressions did not test the full model, the results differed from those presented above. However, Sobel test results were consistent with aforementioned results, thus supporting the robustness of our mediation findings (see Table 3).

We were also interested in whether assault severity affected our results. To examine this, we reran the mediation analyses while controlling for assault severity. These results were the same as our original results. Specifically, when assault severity was controlled for, tonic immobility reduced the predictive value of fear and perceived inescapability for PDS total score, PDS reexperiencing score and PDS avoidance score. Fear no longer significantly predicted reexperiencing scores ($\beta = .09$, *ns*), indicating complete mediation by tonic immobility. However, fear remained significant in predicting PDS total scores ($\beta = .16$, $p < .05$) and avoidance scores ($\beta = .15$, $p = .05$), indicating partial mediation by tonic immobility. Perceived inescapability was no longer a significant predictor of PDS total scores ($\beta = .09$, *ns*), PDS reexperiencing scores ($\beta = .07$, *ns*), or PDS avoidance scores ($\beta = .03$, *ns*), indicating that even when assault severity was controlled for, tonic immobility completely mediated all three variables.

DISCUSSION

Results suggest that tonic immobility may be an important factor in determining whether sexual assault survivors develop PTSD. The relations between fear and both overall PTSD symptom severity and PTSD avoidance/numbing symptoms were partially mediated by tonic immobility. In contrast, the relations between perceived inescapability and both overall PTSD symptom severity and PTSD avoidance/numbing symptoms were fully mediated by tonic immobility. Tonic immobility's partial mediation of the relation between fear and both overall PTSD symptom severity and PTSD avoidance/numbing symptoms suggests that both the development of overall PTSD symptoms and PTSD avoidance/numbing symptoms can occur independent of tonic immobility. However, it also suggests that in certain cases, these outcomes are contingent upon the experience of tonic immobility. Data from a previous study showed that nearly half of sexual assault survivors who experienced tonic immobility symptoms reported them to be extremely frightening (Fusé et al., 2002). Thus, it may be that in certain instances of sexual assault, the fear associated with tonic immobility, rather than the trauma itself, directly influences the development of PTSD symptoms.

Table 3. Standardized Multiple Regressions of Posttraumatic Stress Disorder (PTSD) symptom severity on Fear and Tonic Immobility and on Perceived Inescapability and Tonic Immobility and the Associated Sobel Tests ($N = 176$)

	Fear			Perceived inescapability		
	PDS Total	Reexperiencing	Avoidance	PDS Total	Reexperiencing	Avoidance
Fear (β)	.19**	.11	.19*	–	–	–
PI (β)	–	–	–	.14	.11	.09
TI (β)	.26**	.27**	.26**	.25**	.25**	.28**
Adjusted R^2	.14***	.10***	.13***	.12***	.09***	.12***
Sobel Statistic	2.91**	2.90**	2.91**	2.56*	2.58**	2.82**

Note. PI = Perceived inescapability; TI = tonic immobility; Reexperiencing = reexperiencing symptoms as assessed by the Posttraumatic Diagnostic Scale; Avoidance = avoidance symptoms as assessed by the Posttraumatic Diagnostic Scale; PDS Total = total PTSD score as assessed by the Posttraumatic Diagnostic Scale.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Our finding that tonic immobility either fully (in the case of perceived inescapability) or partially (in the case of peritraumatic fear) mediated the relation with PTSD avoidance/numbing symptoms is consistent with research on animals showing that tonic immobility is associated with both central nervous system opioid-mediated analgesia and enhanced learning of avoidance (Marx et al., 2008). Results also suggest that tonic immobility is important in the development of PTSD reexperiencing symptoms (tonic immobility completely mediated the relations between fear and PTSD reexperiencing symptoms and perceived inescapability and PTSD reexperiencing symptoms.). Although speculative, one possible explanation for this finding is that tonic immobility promotes self-blame for not having done more to prevent the attack (e.g., Metzger, 1976; Mezey & Taylor, 1988; Suarez & Gallup, 1979). Self-blame, in turn, may promote ruminative thinking and intrusions about the experience.

Surprisingly, no significant relation existed between tonic immobility and PTSD hyperarousal symptoms. Though the psychophysiological correlates of tonic immobility vary as a function of species, research with animals (e.g., chickens: Gentle, Jones, & Woolley, 1989; Nash, Gallup, & Czech, 1976; and pointer dogs: Reese, Newton, & Angel, 1982) has found that tonic immobility is associated with decreased autonomic responding. This may also be the case among humans. Another possible explanation for this null finding is that PTSD hyperarousal may be dampened by the same processes that promote peritraumatic dissociation. Although the exact relation between tonic immobility and dissociation is unclear, past research has provided evidence that dissociation is associated with tonic immobility (e.g., Fusé et al., 2007; Heidt et al., 2005). Dissociation has also been associated with suppressed autonomic arousal to trauma reminders (e.g., Griffin, Resick, & Mechanic, 1997; Lanius, Williamson, & Boksman, 2002).

Although the findings of this study are intriguing, the participants were a relatively homogeneous group of nontreatment seeking college students with a limited range of PTSD symptom severity. Thus, the findings may have limited relevance for more heterogeneous, clinical samples. Because we used a group of nontreatment-seeking college students, it is likely that a small number of participants qualified for a PTSD diagnosis. Power analyses revealed that the sample of PTSD sufferers was too small for comparative analyses. Future research should examine whether our model holds for a more severe population. It is also possible that specific aspects of the assault, such as the frequency or recency of the sexual assault or knowledge of the assailant could influence the results. Unfortunately, due to low power, we could not examine the extent to which the relationships reported vary across different levels of such variables. However, because our model held when assault severity was controlled for, it is possible that the model will be applicable across different levels of these variables as well.

Our reliance on cross-sectional self-reports precludes us from determining the exact relation between tonic immobility and PTSD. An alternate possibility to the relationship presented here is that tonic immobility and PTSD are consecutive byproducts of the same subjective experiences and somatic responses to the assault, such as changes in limbic system functions and/or serotonin and neuroendocrine levels (Moskowitz, 2004; Shin, Rauch, & Pitman, 2005; Yehuda, 2002). Likewise, both PTSD and tonic immobility have been associated with genetic predispositions (e.g., McGraw & Klemm, 1973; True, Rice, & Eisen, 1993). As such, the same predisposition may be responsible for the elicitation of tonic immobility and subsequent psychopathology. The retrospective nature of the information collected introduces the possibility of response and memory biases.

Another limitation of this study is that, although the psychometric properties of the TIS-A appear strong, it is a relatively new measure and requires further psychometric evaluation. Although the TIS-A was designed to assess features of tonic immobility, it is likely that this measure will undergo further modification as we learn more about the sequelae to tonic immobility in humans. Related to this limitation, we used a single item to measure survivors' perceived inescapability during the assault. As such, we may not

have fully captured this construct. However, there is currently no validated measure for assessing perceived inescapability. Our use of this item is a first attempt at quantifying the construct.

The results of the current study provide important information that contributes to the growing body of tonic immobility literature. Understanding the importance of tonic immobility as a mediator of the relation between fear and perceived inescapability and the subsequent development of PTSD highlights the importance of continuing to study tonic immobility. These results may be applicable to other traumas. Recent research has provided evidence that tonic immobility occurs during other traumatic experiences besides sexual assault (e.g., physical assault) and that tonic immobility during these traumas also predicts the subsequent development of PTSD symptoms (Bovin, Pontoski, Marx, Sloan, & Forsyth, 2007). Future research should explore whether the model presented here is applicable to other types of traumas.

Research on tonic immobility may also inform our ability to treat sexual assault survivors who experience posttraumatic symptomatology. As discussed, tonic immobility may be associated with subsequent suppression of autonomic responding to trauma reminders. Cognitive–behavioral treatments for PTSD generally aim to decrease physiological arousal to trauma-related cues through strategies such as exposure, relaxation, and cognitive restructuring (Foa & Rothbaum, 1998). Although these strategies may effectively treat many cases of PTSD, they may not be appropriate for all trauma survivors, particularly those who have experienced tonic immobility and do not display autonomic arousal to trauma cues (Hembree, Rauch, & Foa, 2003). Cases of PTSD in which clients responded to trauma with reduced physiological arousal (such as in the case of tonic immobility) may necessitate an alternate treatment strategy, such as increasing arousal to trauma cues. This alternative is consistent with other existing treatment approaches for trauma survivors that emphasize experiencing the somatic sequence of an active defense response through the tracking of physical sensations and increasing arousal (e.g., Levine, 1997; Ogden & Minton, 2002). Importantly, these alternative treatments have not yet been empirically established through independent replications.

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